NEAR-SURFACE RETRIEVAL OF AIR TEMPERATURE AND SPECIFIC HUMIDITY USING MULTI-SENSOR MICROWAVE SATELLITE OBSERVATIONS

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INTRODUCTION

- Current near-surface air temperature (Ta) and specific humidity (Qa) satellite retrieval methods based solely on observations from one satellite instrument.

- Retrieval of Ta and Qa are difficult with current microwave instruments since instruments designed for retrievals of broad vertical layers.

- Temporal and spatial resolution for one instrument does not provide enough global coverage to adequately characterize air-sea heat fluxes.

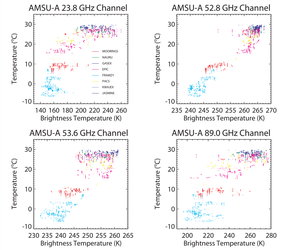
- Combining microwave observations from multiple instruments (AMSU-A, SSM/I, and SSM/T-2) allows for more frequency coverage to develop more accurate retrievals.

DATA AND MATCHING STRATEGY

- Matches required 3 hour / 50 km coincidence between satellite and ship observations.
- Satellite observations screened for land and precipitation contamination.
- The matched data sets combining multiple satellites used the single satellite matched data files.

Satellite 1b observations from AMSU-A, SSM/I and SSM/T-2 were matched to eight sets of Ta and Qa ship observations collected from ETL Turbulent Flux System during several cruises in 1999 and 2001.

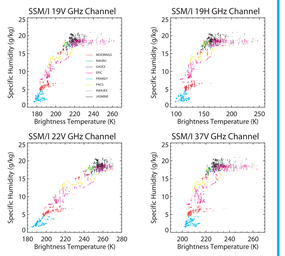
PROJECT	PERIOD	LONGITUDE	LATITUDE
KWAJEX	7/29/99-9/11/99	167E	8N
FRAMZY	4/8/99-4/14/99	6W	62N-71N
MOORINGS	9/14/99-10/13/99	167E-148W	8N-50N
JASMINE	5/15/99-5/31/99	88E-96E	5S-11N
PACS	11/4/99-12/2/99	95W-110W	12N
NAURU	6/18/99-7/18/99	145E-167E	10S-9N
EPIC	9/10/01-10/24/01	101W-71W	EQ-20N
GASEX	2/14/01-2/28/01	125E-131E	2N-3N



CHANNEL SENSITIVITY

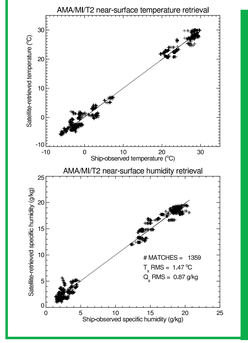
- Ship/satellite matches provide wide range of atmospheric conditions.

- AMSU-A 52.8 GHz and SSM/I 22V channels give most linear relationship with Ta and Qa respectively.



RETRIEVAL METHOD

- A multi-linear regression was applied to different combinations of instruments and channels.
- Matched data between all three satellites were used to develop regressions.
- A forward selection method selected the best channels. When chi-squared reduction became less than 0.1, the channel selection was stopped to prevent over-fitting.
- The regression training set used matches only from FRAMZY, PACS, JASMINE, and KWAJEX.



REGRESSION RESULTS

Best Ta algorithm, RMS difference = 1.47 K

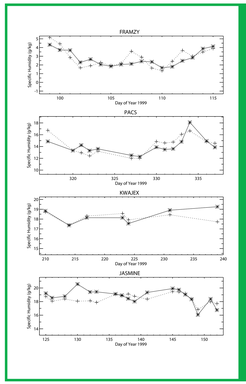
$$Ta = -162.419 + 0.7884*A_{52.8} + 0.249*M_{22V} - 0.0682*A_{89} + 0.2924*M_{19V} - 0.5649*M_{37V} - 0.1308*T_{183+/-1} + 0.1222*T_{183+/-7}$$

Best Qa algorithm, RMS difference = 0.87 g/kg

$$Qa = -95.593 + 0.2843*A_{52.8} + 0.0211*M_{22V} + 0.6157*M_{19V} - 0.1147*M_{19H} - 0.3597*M_{37V}$$

RMS DIFFERENCES FOR VARIOUS INSTRUMENTS

	AM/MI/T2	AM/MI	MI/T2	AM/T2	AM	MI
Qa	0.87 g/kg	0.87 g/kg	0.91 g/kg	N/A	1.04 g/kg	1.13 g/kg
Ta	1.47 K	1.55 K	N/A	1.60 K	2.16 K	N/A

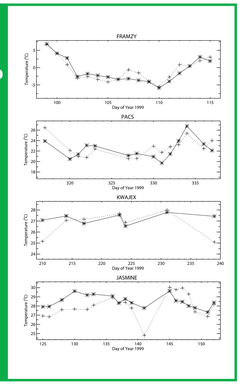


VALIDATION

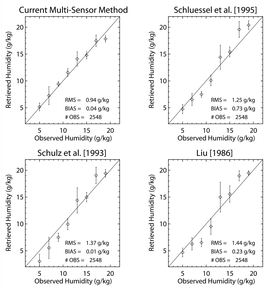
- Used validation matched data set using ship observations from FRAMZY, PACS, KWAJEX, and JASMINE.

- Solid curves = ship observations, dashed curve = satellite retrieval.

- Retrievals are able to capture daily variations of Ta and Qa for Tropical and Mid-latitude conditions.



ALGORITHM COMPARISON

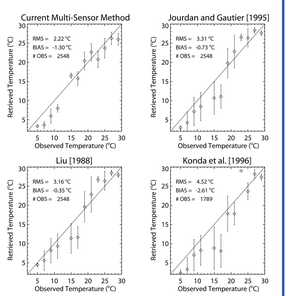


- Validation data set used to compare multi-sensor approach with single-sensor algorithms.

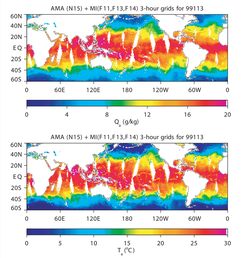
- Multi-sensor approach generally outperforms single-sensor algorithms.

- AMSU-A improves retrievals of Ta and Qa.

- Ta RMS difference increased significantly for validation data set.



COVERAGE



- Trade-off: More instruments = better accuracy = less coverage.
- SSM/I satellites have less temporal coverage.
- AMSU-A satellites provide better diurnal sampling.
- 6-hour global coverage requires AMSU-A data from both NOAA satellites.
- 24-hour global coverage achievable with one instrument.

Percentage of global oceanic coverage over 6- and 24-hour period

	A/M/T	A/M	M/T	A1	A2	M1	M	A+M
6-HR	26.3	40.0	33.0	44.7	79.4	32.0	57.0	61.7
24-HR	69.1	93.4	88.1	97.5	99.9	86.0	98.8	99.7

CONCLUSIONS

- Multiple microwave sensors improves the accuracy of Ta and Qa retrievals.
- AMSU-A improves both retrievals.
- AMSU-A 52.8 GHz and SSM/I 22V are dominate channels in both retrievals.
- Channels not directly sensitive to Ta and Qa also improve the retrievals.
- 6-hour oceanic coverage is nearly attainable when using AMSU-A from both NOAA satellites.
- Combining multi-sensor and single retrievals could provide a significant archive of air-sea heat flux observations.